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Chromosome numbers in some Mosses from New Zealand

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Abstract

Additional chromosome information, based on meiotic studies, is reported here for 27 species (of which eight are endemic) in 22 genera of New Zealand mosses in the following 14 families: Amblystegiaceae, Bartramiaceae, Bruchiaceae, Dicnemonaceae, Ditrichaceae, Funariaceae, Hypnaceae, Hypopterygiaceae, Lembophyllaceae, Leptostomaceae, Pottiaceae, Ptychomniaceae, Racopilaceae, Rhizogoniaceae. When added to the previous chromosome number records for 39 species, data are now available for 66 species.

Introduction

The New Zealand moss flora has proved of great interest for a long time (Dixon 1913–1929, Sainsbury 1945, 1955, Allison 1971, Allison & Child 1971, Bartlett 1984, Beever et al. 1992) and its bryoflora has been well studied taxonomically with the report of at least 525 mosses, 500 hepatics and 15 hornworts (Fife 1985, 1996). However, chromosome studies of New Zealand bryophytes are relatively few as noted by Fife (1996). There have been some further chromosome records published since 1994 e.g. for Bryaceae, *Dicranoloma* (Dicranaceae), *Hypnodendron* in which the low numbers n=4, 5 were recorded, Orthotrichaceae, Polytrichaceae, Sematophyllaceae families for which no additional reports are given here. These are listed in Table 1, together with the references, bringing reports available, prior to these studies, to 39 species in 22 genera of mosses.

Materials and Methods

The techniques used follow those in Ramsay (1974, 1983) with mainly meiotic studies using aceto-orcein or aceto-carmine squashes. Slides were made permanent by freezing with carbon dioxide and mounting in euparal so that many of the slides still remain suitable for study, after more than 30 years. Vouchers for chromosome counts will be deposited at the National Herbarium of New South Wales (NSW).

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Table 1. Previously published chromosome number records for New Zealand mosses

Family and Species	Chromosome number	Reference
Amblystegiaceae		
Sanionia uncinata	2n=20	Przywara et al. 1992
Bartramiaceae		
Breutelia pendula	n=6	Przywara et al. 1992
Philonotis tenuis	n=6	Newton 1973
Bryaceae		
Ochiobryum blandum (as *Bryum blandum*)	n=11	Ramsay & Spence 1996
Gemmabryum sauteri (as *Bryum sauteri*)	n=10	Ramsay & Spence 1996
Dicranaceae		
Dicranoloma billarderi	n=12	Przywara et al. 1992
Dicranoloma billarderi	n=12	Ramsay 2006
Dicranoloma dicarpum	n=7	Ramsay 2006
Dicranoloma plurisetum	n=8	Ramsay 2006
Dicranoloma platycaulon	n=7	Ramsay 2006
Dicranoloma robustum [includes *Dicranoloma cylindropyxis*]	n=7	Ramsay 2006
Dicranoloma menziesii	n=8	Ramsay 2006
Hypnaceae		
Ctenidium pubescens	n= 8	Nishimura & Inoue 1985
Hypnodendraceae		
Hypnodendron arcuatum	n=9	Ramsay 1987
Hypnodendron colensoi	n=5	Ramsay 1987
Hypnodendron comatum	n=4	Ramsay 1987
Hypnodendron comosum	n=4	Ramsay 1987
Hypnodendron kerrii	n=9	Ramsay 1987
Hypnodendron marginatum	n=9	Ramsay 1987
Hypnodendron menziesii	n=5	Newton 1973
Hypnodendron spininervium	n=9	Ramsay 1987
Hypopterygiaceae		
Cyathophorum bulbosum	n=5	Newton 1973
Hypopterygium didictyon (as *H. novae-seelandiae*)	n=6	Newton 1973
Lembophyllaceae		
Acrocladium chlamydophyllum	2n=22	Przywara et al. 1992
Orthotrichaceae		
Orthotrichum calvum	n=6	Ramsay & Lewinsky 1984
Orthotrichum tasmanicum var. *tasmanicum*	n=6	Ramsay & Lewinsky 1984, Ramsay 1993
Orthotrichum graphiomitrium	n=6	Ramsay & Lewinsky 1984
Orthotrichum hortense	n=6	Ramsay & Lewinsky 1984
Ulota lutea	n=11	Ramsay 1993
Ulota viridis	n=11	Ramsay 1993
Zygodon intermedius	n=11	Ramsay 1993
Zygodon minutus	n=16	Ramsay 1993
Macrocoma tenue	n=11	Ramsay & Vitt 1986
Macromitrium gracile	n=9	Ramsay & Vitt 1986
Macromitrium grossirete	n=9	Ramsay & Vitt 1986
Macromitrium submucronifolium	n=10	Ramsay & Vitt 1986

Family and Species	Chromosome number	Reference
Macromitrium longipes	n=9	Ramsay & Vitt 1986
Macromitrium microstomum	n=11	Ramsay & Vitt 1986
Macromitrium gracile	n=9	Ramsay & Vitt 1986
Ptychomniaceae		
Ptychomnium aciculare	n=7	Przywara et al. 1992
Polytrichaceae		
Atrichum androgynum	n=14	Ramsay 1997
Notoligotrichum australe	n=7	Ramsay 1997
Polytrichadelphus magellanicus	n=7	Ramsay 1997
Sematophyllaceae		
Warburgiella leucocyta	n=11	Ramsay et al. 2002

New Chromosome Records

Chromosome numbers already published worldwide have been obtained from indices produced by Fritsch (1991), Kuta et al. (1990) and Goldblatt and Johnson (1994–2006). New counts for 27 species in 22 genera and 14 families, with the collector and collector's specimen number and locality details are listed in Table 2.

Taxa endemic to New Zealand (8 species) are indicated thus *.

Family Amblystegiaceae

The subfamily Campylioideae was raised to the status of family as Campyliaceae by W.R. Buck (Buck & Goffinet 2000) with 18 genera including *Drepanocladus, Warnstorfia* and *Sanionia* which occur in New Zealand. However, more recent studies of the family based on nuclear and chloroplast DNA by Hedenas et al. (2002) and Goffinet and Buck (2004) have returned this family to the Amblystegiaceae

The genus *Drepanocladus* (Müll.Hal.) G.Roth was divided into several genera, e.g. *Sanionia, Warnstorfia* (Goffinet & Buck 2004, Fife 1995) with two species – *Drepanocladus aduncus*, and *D. polygamus* (*Campylium polygamus*) now recognised for New Zealand. The chromosome numbers n=10, 11, 12, 20, 22, 24 have been recorded for *D. aduncus* (Fritsch 1991, Goldblatt & Johnson 1996) from Europe, USSR, USA. Former chromosome number reports for *Sanionia uncinata* (as *Drepanocladus*) include n=10, 11, 12, 20, 30 from Europe, North America and Japan (Fritsch 1991, Goldblatt & Johnson 1996).

Chromosome numbers are determined here for one species of *Drepanocladus*, and one of *Sanionia* in New Zealand. These are the first for *Drepanocladus* while Przywara et al. (1992) recorded 2n=20 for *Sanionia uncinata* from sporophytic mitosis (Table 1) for New Zealand

1. ***Drepanocladus aduncus*** (Hedw.) Warnst. n=10, **Fig. 1.1**

The New Zealand population (Table 2) had the number n=10 which corresponds to one of the numbers reported overseas.

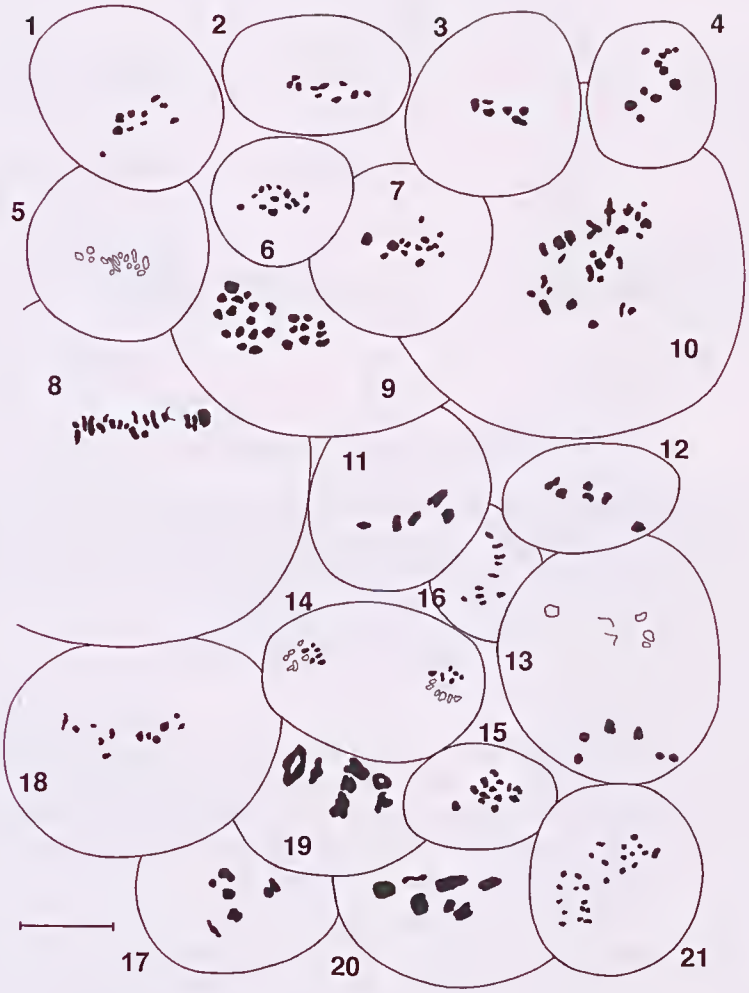

Fig. 1. Meiotic chromosomes in New Zealand mosses. **1.** *Drepanocladus aduncus* (84/84) n=10; **2.** *Sanionia uncinata* (75/84) n=10; **3.** *Philonotis pyriformis* (41/87) n=6; **4.** *Rhynchostegium tenuifolium* (63/84) n=11; **5.** *Trematodon suberectus* (43/87) n=14; **6.** *Ditrichum brachycarpum* (7/84) n=13;. **7.** *Ditrichum brevirostre* (20/87) n=13; **8.** *Entosthodon* species 1 (79/84) n=18; **9.** *Entosthodon laxus* (1/84 n=24; **10.** *Entosthodon* species 2. (97/84) n=26. **11.***Cyathophorum bulbosum* (13/83) n=5; **12.** *Hypopterygium didictyon* (7/80) n=6; **13** & **14** *Leptostomum inclinans* (84/84) n=6. **13.** Anaphase I showing the six half bivalents moving to opposite poles; **14.** Anaphase II showing two Metaphase II plates with 6 chromosomes separating to each end. **15.** *Tortella mooreae* (1/86) n=13; **16.** *Racopilum cuspidigerum var. convolutaceum.* (29/87) n=10; **17.** *Cryptopodon bartramioides* (56/84) n=7; **18.** *Tortula breviseta* (85/84) n=12; **19.** *Dichelodontium nitidum* (101/84) n=7, note smallest bivalent separated early; **20.** *Cladomnion ericoides.* (104/82) n=7; **21.** *Weissia austrocrispa* (58/83) n=26; scale bar 10 μm

Table 2. Additional chromosome records for New Zealand mosses (alphabetical by genus). Unless otherwise stated, collections were made by the author; often with J.E. Beever as my guide on either the North Island (NI) and/or South Island (SI) of New Zealand. JEB – Jessica Beever; AJF Allan J. Fife. Taxa endemic to New Zealand (8 species) are indicated thus *. Vouchers will be deposited at the National Herbarium of New South Wales (NSW).

Taxon	Chromosome number (n)	Voucher specimen & locality data
Acrocladium chlamydophyllum	11	72/84 NI, Mt Ruapehu.
**Cladomnion ericoides*	7	104/84 NI, Mt Ruapehu
**Cryptopodium bartramioides*	7	67/84 NI, Renata track; Akatarawas; 56/84, Kapakapanui track, Akatarawas
Ctenidium pubescens	8	NI, JEB 21-14, Rangitoto Is.; JEB 27-15 Little Barrier Is
Cyathophorum bulbosum	5	13/83 SI, Leith Saddle, Dunedin HPR with J. Child
**Dichelodontium nitidum*	10	62/84 NI, Mt Ruapehu, 101/84 NI, Mt Ruapehu
Dicnemon calycinum	7	102/84 NI, Mt Ruapehu
**Dicnemon semicryptum*	7	107/84 NI, Mt Ruapehu,
**Ditrichum brachycarpum*	13	7/84 SI, Milford Sound L.E. Anderson 65/84 NI, Mt Ruapehu.
Ditrichum brevirostre	13	20/87 SI, Red Hills,
Drepanocladus aduncus	10	84/84, NI, Mt Ruapehu
Entosthodon laxus	24	1/84 SI, AJF
Entosthodon sp. 1	18	79/84 SI, AJF
Entosthodon sp. 2	26	97/84 NI, Mt Ruapehu
Glyphothecium scuiroides	7	61/84 NI Mt Ruapehu
Hypopterygium didictyon	6	7/80 SI, with J. Child
Leptostomum inclinans	6	82/84 NI, Mt Ruapehu
**Philonotis pyriformis*	6	41/87 SI, Lake Rotoroa
Ptychomnion aciculare	7	7/83 NI, Waitakere Ra.
Racopilum cuspidigerum var. *convolutaceum*	10	29/87, SI, Red Hills
Rhynchostegium tenuifolium	11	77/84 NI, Mt Ruapehu 63/84 NI, Mt Ruapehu
Sanionia uncinata	10	75/84 NI, Mt Ruapehu
**Tortella mooreae*	13	1/86, 2/86 NI, Rangitoto Is., JEB 38-27, 38-28
Tortula breviseta	12	83/84, 85/84 NI, Mt Ruapehu
**Trematodon suberectus*	14	8/83, NI, JEB 21-32, Ngaruawahia, S. Auckland 43/87 SI, Lake Rotoroa
Weissia austrocrispa	26	58/83 SI AJF

2. *Sanionia uncinata* (Hedw.) Loeske n=10, **Fig. 1.2**

The New Zealand population studied here was epiphytic on tree bark in the Wakapapanui alpine garden on Mt Ruapehu (Table 2) and had the meiotic chromosome number n=10. This gametophytic count corresponds to the previous sporophytic count of 2n=20 by Przywara et al. (1992).

Family Bartramiaceae

Beever et al. (1992) report three species of *Philonotis* from New Zealand. The mitotic chromosome number of n=6 was recorded for *Philonotis tenuis* from the South Island by Newton (1973). Previous chromosome records for other species in the genus are

n=6, 12 (Fritsch 1991, Goldblatt & Johnson 2000) from Europe, India, Japan, Australia, China and Chile.

***3. *Philonotis pyriformis* (R.Br. bis) Wijk & Margad. n=6, Fig. 1.3**

The chromosome number of n=6 is reported here for *Philonotis pyriformis* and represents the first record for this species in New Zealand. (Table 2). The number and morphology of the six bivalents at meiosis correspond to those reported for other *Philonotis* species.

Family Brachytheciaceae

The family Brachytheciaceae in New Zealand includes the genera *Brachythecium, Rhynchostegium, Eurhynchium* with several species in each as well as several smaller monospecific genera (Beever et al. 1992). There are no previous chromosome records from New Zealand for this family. The chromosome numbers n=8, 10, 11, 12, 14, 20, 22 have been recorded from India, Europe, Japan and Australia for a number of species of *Rhynchostegium* with some of these including an m-chromosome (Fritsch 1991). Previous studies record the chromosome numbers n=20+2m, 22 and polyploid numbers for specimens of *R. tenuifolium* (including those under *R. laxatum*) from Australia (Ramsay 1974).

4. *Rhynchostegium tenuifolium* (Hedw.) Reichardt n=11, Fig. 1.4

In New Zealand (Table 2) the number n=11 was recorded for both populations studied. These had a haploid complement and were not polyploid as were those recorded for Australia so far (Table 1).

Family Bruchiaceae

The genus *Trematodon,* formerly in the Dicranaceae, has been placed in the Bruchiaceae in the recent classification by Goffinet and Buck (2004). Previous chromosome records for *Trematodon* from the Northern Hemisphere (India, U.S.A., Canada, Alaska see Fritsch 1991, Ireland 1991 in Goldblatt & Johnson 1994) are n=11, 13+m, 13+2m, 14, 14+m with polyploids n=28, 28+m, 28+2m, some cytotypes including one or two 'm' chromosomes.

***5. *Trematodon suberectus* Mitt. n=14, Fig 1.5**

T. suberectus is one of three species of *Trematodon* recorded for New Zealand (Beever et al. 1992). The chromosome number n=14 is reported here for *T. suberectus* in two separate collections (Table 2) and is the first record for this genus from New Zealand.

Family Dicranaceae [Dicnemonaceae]

The southern hemisphere family Dicnemonaceae, formerly a subfamily of the Dicranaceae was validated as a family by Brotherus (1924) who recognised five genera. In a later analysis of the family, Allen (1987) retained only *Dicnemon, Encamptodon* and *Synodontium* while Buck and Goffinet (2000) transferred *Synodontium* elsewhere retaining only *Dicnemon and Encamptodon.* The genus *Dicnemon* is reported from New Guinea, Vanuatu, New Caledonia, Australia and New Zealand while *Encamptodon* is distributed in Australia, New Caledonia and South America but is absent from New Zealand (Allen 1987). More recent studies based on DNA analyses (Hedenas et al. 2002, Goffinet & Buck 2004) have returned the Dicnemonaceae to the Dicranaceae.

Observations of sporocytes under light microscopy indicate that the nucleus and cytoplasm are at one end of the sporocyte, while a large vacuolar area exists at the other

end. Sporocytes are smaller and rectangular in *D. calycinum* (Fig. 2.1) and larger more oval in *D. semicryptum* (Fig. 2.2). In *Encamptodon* the sporocytes are spherical with a central nucleus as in other mosses.

The sporocytes in *Dicnemon* are arranged as a single layer around the columella and following meiosis form a ring of 8–12 spores in cross section and 8 columns in rows longitudinally (Allen 1987). At the time of meiosis in these studies the capsule was green and translucent with a coloured annulus in *Dicnemon semicryptum* but in *D. calycinum* the annulus coloured later, after spores were produced. The operculum and peristome became coloured at the young spore stage in both species.

Following meiosis and early spore formation, rapid and simultaneous mitoses lead to the production of large multicellular spores (to 700 µm). In both *D. semicryptum* and *D. calycinum* they are freed from the capsule as tetrahedral protonema.

These are not shed directly but the columella dries out and the multicellular protonemata are dislodged by splashing in heavy rain, i.e. in conditions suitable for germination.

There are no previous chromosome records for *Dicnemon* and none yet for *Encamptodon*.

6. *Dicnemon calycinum* (Hook.) Schwägr. n=7, **Fig. 2.1**

The chromosome number n=7 was obtained for *Dicnemon calycinum* (Table 2) at anaphase I with seven half bivalents moving to each pole. Meiosis occurs towards one

Fig. 2. Chromosome numbers in *Dicnemon* – large sporocytes with meiotic chromosomes towards one end of cell; **1.** *Dicnemon calycinum (107/84)*. Anaphase I of meiosis showing 7 half bivalents moving to each pole in the smaller sporocyte; **2.** *Dicnemon semicryptum* (102/84). Metaphase I of meiosis in larger sporocyte. Scale bar 10 µm

end of the sporocyte, not centrally as in most mosses. The sporocytes are smaller in *D. calycinum* than in *D. semicryptum*.

***7. *Dicnemon semicryptum* Müll.Hal. n=7, Fig. 2.2**

As the nucleus is situated at one end of the very large sporocyte in the specimens of *D. semicryptum* (Table 2), meiosis is also not centrally positioned. At metaphase I of meiosis the seven bivalents were fully contracted with one larger bivalent.

Family Ditrichaceae

The family Ditrichaceae contains some 24 genera (Goffinet & Buck 2004) of which eight genera including *Ditrichum, Ceratodon, Distichium, Eccremidium* and *Pleuridium*, occur in New Zealand. Of these, *Ditrichum* with 12 species (Beever et al. 1992) is the largest. Chromosome data for a number of species of *Ditrichum* from Europe, U.S.A. and India, give the number as predominantly n=13, sometimes with an additional m-chromosome or sometimes polyploids with n=26 (Fritsch 1991, Goldblatt & Johnson 1994, 1996, 2003). Chromosome numbers have been recorded for the single species *D. difficile* from Australia n=13, 13+m (Ramsay 1974) but there are no previous records from New Zealand.

***8. *Ditrichum brachycarpum* Hampe n=13, Fig. 1.6**

9. *Ditrichum brevirostre* (R.Br.bis.) Broth. n=13, Fig. 1.7

Both species of *Ditrichum* studied (Table 2), had the chromosome number n=13. The two collections of *Ditrichum brachycarpum* examined were collected at different times and in different localities on the South Island (Table 2).

Family Funariaceae

Fife (1982, 1985, 1985a, 1986, 1996) and Fife and Seppelt (2001) have revised the various taxa in the Funariaceae for Australasia. They recognise six species of *Entosthodon* (smooth capsules) and two species of *Funaria* (grooved capsules) for New Zealand.

Chromosome data are available for a number of taxa as *Entosthodon* or *Funaria* from North America, Europe, India and Australia (see Fritsch 1991, Goldblatt & Johnson 1994). A recent count (Goldblatt & Johnson 2000) for *Entosthodon wichurae* from India is n=7 representing the probable basic number of the family. Numbers for other species include n=14, 21, 24, 26, 27, 28, 42, 52, 54, 56. Information is provided here for 3 species.

10. *Entosthodon laxus* (Hook.f. & Wilson) Mitt n=24, Fig 1.9

Formerly *Funaria apophysata*, now known as *Entosthodon laxus*, has the chromosome number n=24, the first for this species for a collection from the South Island by A.J. Fife (Table 2).

11. *Entosthodon* species 1, n=18, Fig. 1.8

The chromosome number of n=18 determined here for a New Zealand collection of *Entosthodon* for an as yet unidentified species from the South Island made by A.J. Fife (Table 2) is the first with the chromosome number n=18.

12. *Entosthodon* species 2, n=26, **Fig. 1.10**

This as yet unidentified species has the chromosome number n=26 for a collection from Mt Ruapehu (Table 2).

Family Hypnaceae

The Hypnaceae is a large family of mosses with some 62 genera (Buck & Goffinet 2000). The family is not well represented in Australasia and in New Zealand only the four genera *Hypnum* (two species), *Ctenidium*, *Fallaciella* (formerly *Camptochaete gracilis*) and *Ectropothecium*, each with a single species, are present.

Chromosome numbers for the family of n=11 (five species) and n=8 (four species) have been reported for nine species from Europe, North America, New Zealand and Japan mainly by Nishimura et al. (see Fritsch 1991) based on mitotic studies. These included n=8 for *Ctenidium pubescens* in New Zealand (Nishimura & Inoue 1985).

13. *Ctenidium pubescens* (Hook.f. & Wilson) Broth. n=8.

Ctenidium is a small genus with 21 species worldwide (Nishimura 1985). In these studies of meiosis, the chromosome number for *C. pubescens* in New Zealand is confirmed as n=8. but no illustrations are included here. The collections were obtained from localities near Auckland (Table 2) close to that from which J.E. Beever obtained the specimens sent to Nishimura.

Family Hypopterygiaceae

A recent revision of the family Hypopterygiaceae by Kruijer (2002) has renamed a number of former *Hypopterygium* species. Newton (1973) reported n=6 for *Hypopterygium didictyon* (formerly *H. novae-seelandiae*) while Ramsay (1967) reported studies on a population from Australia of *H. tamarisci* (as *H. rotulatum*) with various cytotypes and the numbers n=9, 18, 27, 36. The chromosome number for *Cyathophorum bulbosum* from New Zealand examined mitotically by Newton (1973) is n=5 and is the same for Australia examined meiotically (Ramsay 1974).

14. *Cyathophorum bulbosum* (Hedw.) Müll.Hal. n=5, **Fig. 1.11**

The meiotic chromosome number recorded here for *Cyathophorum bulbosum* from Dunedin (Table 2) had the same chromosome number n=5 and similar bivalents to the Australian collections examined previously.

15. *Hypopterygium didictyon* Müll.Hal. n=6, **Fig. 1.12**

These studies provided the meiotic chromosome number of n=6 for *H. didictyon* (Table 2) confirming that determined by Newton (1973) (as *H. novaeseelandiae*) based on gametophytic mitosis.

Family Lembophyllaceae

The family Lembophyllaceae was revised by Tangney (1997) and includes eight genera of which five have representatives in New Zealand. Przywara et al. (1992) recorded the chromosome number 2n=22 based on sporophytic mitotic studies for *Acrocladium chlamydophyllum* from New Zealand. This corresponds to a meiotic count of n=11. Australian studies have previously reported the chromosome number for *Acrocladium chlamydophyllum* (Hook.f. & Wilson) Müll.Hal. & Broth. as n=11 (10+m), [as *A.*

auriculatum (Mont.) Mitt.] at meiosis (Ramsay 1974). Chromosome numbers for *Lembophyllum divulsum* (Hook.f. & Wilson) Lindb. n=10, and *Camptochaete deflexa* (Wilson) A.Jaeger [as *C. ramulosa* (Mitt.) A.Jaeger] n=10, 11, 22 and n=11 for *C. excavata* (Taylor) A.Jaeger [as *C. vaga* (Hornsch. ex Müll.Hal.) Broth.] have been recorded for Australian species (Fritsch 1991).

16. *Acrocladium chlamydophyllum* (Hook.f. & Wilson) Müll.Hal. & Broth., n=11.

The meiotic chromosome number was verified as n=11 for a population from New Zealand (Table 2) and corresponds to the sporophytic mitotic count of n=22 made by Przywara et al. (1992). No illustration is included here.

Family Leptostomaceae

The Leptostomaceae is a southern hemisphere family distributed in Australia, New Zealand and Papua New Guinea. It contains a single genus *Leptostomum* with two species in New Zealand (Beever et al. 1992). The chromosome numbers n=6, 12 have been reported previously for *L. inclinans* in Australia (Ramsay 1967, 1974).

17. *Leptostomum inclinans* R.Br. n=6, **Figs. 1.13 & 1.14**

This is the first chromosome count for *Leptostomum inclinans* in New Zealand (Table 2). The number n=6, (Fig. 1.13) at anaphase I corresponds to that found for Australian specimens. Many sporocytes were at metaphase II where the count could be confirmed, Fig. 1.14.

Family Pottiaceae

The family Pottiaceae contains a very large number of taxa with a high range of chromosome numbers within individual species for a number of genera such as *Tortula* (some species now recorded as *Syntrichia* by Zander (1993)), *Tortella, Trichostomum* and *Weissia.*

***18. *Tortella mooreae* Sainsbury n=13,** **Fig. 1.15**

Tortella mooreae is a New Zealand endemic species and the specimens examined here, collected by J.E. Beever, came from islands near Auckland, North Island (Table 2). The chromosome number, the first report for the species, was determined as n=13 in both collections.

The genus *Tortula* is a large genus of colonising mosses with many species and a wide range of chromosome numbers. There are numbers available for more than 50 species worldwide; n=7 (6+m), 12, 13, 24, 26, 28, 36, 48, 50, 52, 66 which include high intraspecific and interspecific polyploids (Fritsch 1991).

19. *Tortula brevisetacea* (F.Muell.) Thér. n=12, **Fig. 1.18**

There are no previous chromosome records for this New Zealand species. The number reported here (Table 2) is n=12.

Weissia is another widespread colonising genus in the Potticaceae with many species. Chromosome numbers for some species reported in Fritsch (1991) from North America, Europe, India, Japan and Australia are n=13, 14, 26.

20. *Weissia anstrocrispa* (Beckett) I.G.Stone n=26, **Fig. 1.21**

This species (in Beever et. al. 1992 as *Astomum anstrocrispum* (Beckett) Broth.) is present in New Zealand and Australia (Streimann & Klazenga 2002). The chromosome number of n=26 was obtained from specimens collected by Allan Fife (Table 2) and is the first for the species.

Family Ptychomniaceae

The family Ptychomniaceae is a southern hemisphere pleurocarpous family. There are 6 recognised genera (Buck & Goffinet 2004) including *Dichelodontium*, *Ptychomnion*, *Cladomnion*, *Hampeella* and *Glyphothecium*. *Cladomnion* is monotypic and endemic to New Zealand. The genus *Ptychomnion* has one species, *P. aciculare*, in New Zealand and Australia and another species, *P. densifolium*, found in New Zealand at high altitudes and on subantarctic islands. The chromosome number n=7 has been recorded previously for Australian species of *Glyphothecium* and *Ptychomnion* (Ramsay 1967, 1974).

***21. *Dichelodontium nitidum* (Hook.f. & Wilson) Broth. n=7,** **Fig. 1.19**

Both collections of *D. nitidum* examined here (Table 2) had the chromosome number of n=7, with comparatively large chromosomes. These are the first records for this genus and species. The number supports its relationship to other taxa in the family.

***22. *Cladomnion ericoides* (Hook.) Hook. f. & Wilson n=7,** **Fig. 1.20**

There are no previous chromosome number records for the genus *Cladomnion*. The number n=7 (Table 2), is reported here and includes a small bivalent (not an m-bivalent) which disjoins early. This is the same number as for the related genus *Ptychomnion* both here and in Australia and the other genera in the family studied here.

23. *Ptychomnion aciculare* (Brid.) Mitt., n=7.

The chromosome number n=7 was reported for *P. aciculare* in Australia (Ramsay 1974). This number is confirmed here for a New Zealand population (Table 2) with bivalents similar to those for Australian collections. The bivalents included one smaller one that disjoined early but was not an m-chromosome. No illustration is included here.

24. *Glyphothecium sciuroides* (Hook.) Hampe n=7.

In this study the chromosome number n=7 was reliably confirmed for two New Zealand populations (Table 2). This corresponds with the number n=7 determined previously for an Australian population (Ramsay 1974). No illustration is included here.

Family Rhizogoniaceae

The family Rhizogoniaceae is represented in New Zealand by the genera *Pyrrhobryum*, *Rhizogonium*, *Cryptopodium*, *Goniobryum* and *Hymenodon*. There have been a number of chromosome studies for various genera in the family, including counts of n=6, for two different species of *Pyrrhobryum* (one as *Rhizogonium paramattense*), n=12 for *Pyrrhobryum mnioides* and n=5 for *Rhizogonium novaehollandiae* in Australia (Ramsay 1974) [for photographs see figs 22–31 in Ramsay 1983] as well as n=6 and or n=12 for *P. spiniforme* (as *Rhizogonium*) from America, Japan (Fritsch 1991) and Papua New Guinea (Ramsay 2008).

Cryptopodium is a monotypic New Zealand endemic moss (Fife 1995) commonly found on the lower trunks of tree ferns.

***25. *Cryptopodium bartramioides* (Hook.) Brid. n=7,** **Fig. 1.17**

This is the first chromosome report for *Cryptopodium bartramioides*, determined from collections from two different localities (Table 2). The chromosomes are large and the meiotic chromosome number n=7 corresponds well with those recorded for other taxa in the family.

Family Racopilaceae

The family Racopilaceae contains two genera, *Powellia* with two species occurring in tropical regions and *Racopilum* a primarily southern hemisphere genus of 20 species occurring in South America, Africa, south-eastern Asia Australia and New Zealand. Chromosome counts of n=10 have been published for six species of *Racopilum* (Fritsch 1991) with the polyploid number n=20 for *R. tomentosum* from South America. In Australia the number n=10 was published for *R. cuspidigerum* var. *convolutaceum* as *R. convolutaceum* and also includes a collection incorrectly named as *R. strumiferum* (Ramsay 1974). *R. strumiferum*, present in New Zealand and Australia, has the number n=10 (de Vries et al. 1989, Zanten 2006) in New Zealand.

26. *Racopilum cuspidigerum* (Schwägr.) Ångstr. var. *convolutaceum* (Müll.Hal.) Zanten & Dijkstra. n=10, **Fig. 1.16**

This report (Table 2) confirms the number as n=10 for this taxon and is the first record from New Zealand.

Discussion

These additional studies bring the total chromosome data to 12% of the species present in New Zealand. Many taxa, including endemic species, have not been investigated There is therefore an obvious need for more cytological studies on New Zealand mosses. Such studies may highlight extra characters for the species and, where aneuploidy or polyploidy occurs, give some information on the evolution occurring both intra- and inter- specifically that may not be available from molecular studies.

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